A summary of studies conducted on the effect of motion in flight simulators pilot training

Aviation Focus
Suite D, 6/F., Ho Lee Commercial Building
38-44 D'Aguilar Street, Central
Hong Kong
+852 2251 8382
info@aviationfocus.aero
www.aviationfocus.aero

Contents

1. Controlled studies that examine the contribution of motion cueing to flight simulation.

We have reviewed many papers on the use of motion systems in flight simulators used for both initial and type-specific pilot training. Of particular interest is a series of studies carried out in co-operation with the FAA, NASA and the United States Department of Transport.

This research is summarized below and is a companion to our recent paper on the evolution of motion and visual systems in flight simulators. Download Document Motion in Flight Simulators

First Series

Training and Evaluation in a FFS with the motion platform on ("full" motion), or off (no motion).

In the first series, two groups of pilots carried out training for a B747-400 type rating. One group was trained and evaluated on a FFS with all systems operating normally (motion on group). The other group was trained and evaluated on the same FFS but with the motion platform switched off (motion off group). The results were then compared on a quantitative basis (success rate/maneuver parameters between groups) and a qualitative basis (de briefing of test subjects and their simulator instructors.) Both groups were then evaluated on the FFS with the motion ON, at the so-called "Quasi-transfer" phase. Quasi-transfer in this context means "instead of transfer onto the real airplane". Quasi-transfer was used because some of the maneuvers would not be practiced in a real airplane.

None of the pilot participants were told either the purpose of the tests or if motion was on or off. Great care was taken in the selection of the pilot groups and in the measurement and analysis of flight test/training maneuvers and parameters in order to ensure that the results were statistically significant.

The results of this study showed some small differences in performance parameters during training and evaluation with the "no motion group doing marginally better. These effects were small and did not impact upon the successful outcome of training. The group trained with motion performed slightly better than those trained without motion in terms of reaction time during a V1 Cut. However these effects disappeared upon quasi-transfer to the FFS.

There was no qualitative difference between groups and both related similar experiences of the training and evaluation, in particular, the group trained without motion said that their experience was similar to previous training in FFS and some of them did not mention motion at all. [Remember, no one was told if motion was on or off.] This last observation may mean that these pilots "thought" that motion was on, or that the lack of motion was not perceived.

The authors concluded that the use of motion platforms in both training and evaluation did not have a significant effect upon the outcome. They suggested that this information would assist aviation authorities in further studies and to finding a more cost-effective solution to today's pilot training needs via appropriate combination of FBS and FFS in integrated training courses, evaluation and testing.

Second series.

Conducting a Type Rating course using only a FBS for training. Evaluation carried out on the actual airplane.

In this paper, the authors first explain how motion is produced, sensed and perceived in an airplane and in a simulator. Just as in our study of motion, (link) they conclude that motion in a simulator is neither accurate nor comparable with motion in an airplane.

They suggest, therefore, that type-specific pilot training could be carried out effectively in a fixed base device.

To test this hypothesis, this study looked at the conduct of type rating training using only a FBS, followed by evaluation in an airplane. This arrangement is a "real" transfer (transfer to an airplane for evaluation) rather than a "quasi" transfer (transfer to a FFS for evaluation). The (fixed base) simulators used were,

FFT-1. Fixed base, projection visual, non-collimated, 180/40 FOV. NAA qualified for TR/Recurrent training.

FFT-X. Fixed base, collimated, 180/40 FOV. Motion cueing seats. NAA qualified for TR/Recurrent training and some testing credits (equivalent to FFS Level B).

Training was carried out first on the FFT-1, then on the FFT-X, and then a TR Skill test was carried out on the FFT-X. Finally, airplane testing was carried out and the TR granted. All pilots completed the TR successfully and the qualitative analysis of performance showed that acceptable skill levels were present during training and evaluation.

Third series.

Training on a Full Flight Trainer (Fixed base with motion cueing seat) and a Full Flight Simulator.

Third series reports on outcomes after training on FFT and FFS and also includes low experience pilots in the sample group. In this series, all testing was carried out on FFS.

That study concludes that, because motion platforms in general provide poor or inadequate cues, the FFT trained group performed with no disadvantage to the FFS trained group.

Summary.

This research has demonstrated that, in the above series of tests, the absence of a motion platform has no outcome in either training or testing. It also shows that training and (initial) testing can take place on a Fixed Base Simulator and that this leads to successful completion of a TR regardless of the testing/evaluation equipment (FFS or Aircraft).

The research has concluded that, in many cases, pilots trained in FBS perform better at evaluation phase (FFS or airplane) and they speculate that inadequate or inaccurate motion cues in FFS may distract or divert attention from control of flight parameters using information from flight deck instruments, control-loading feedback, and visual stimuli (all of which may be accurately modeled in a Simulator.)

The authors comment that, despite the experimental evidence against the use of motion platforms in flight simulator training, there are many commercial factors that conspire against change, including the “profits that can be gained from selling such [motion] systems”.

The authors are concerned however, that such considerations make it much more expensive for FTO’s and even airlines, to carry out better and more cost-efficient pilot training. They suggest further that the travelling public would obviously benefit from such training through increased flight safety.

A (so-called) motion-cueing seat has been used on certain of the Fixed Base devices in some of these studies. There is no indication from this research that such a seat has an outcome at any stage of training and it can be suggested that the very limited motion cues are rather crude and therefore of no particular value.

MPS Flight Simulators.

Flight Simulation has evolved together with the expansion of the Transport Industry in order to help airlines and training organizations provide pilot training that is of high quality.

The complexity and variety of airline types now in operation around the world means that such training is very expensive. MPS Simulators have been designed to address this by taking account of current research and best practice. This has been achieved by attention to flight deck environment, accurate control loading and response (the simulator must fly like the aircraft) and, finally the perception of motion as provided by a level D visual system.

Much evidence is available that a motion platform is not a necessary part of the "Total Simulation Experience" and MPS Simulators provide accurate flight simulation comparable in experience AND outcome to a FFS.

Further, this quality simulation can be provided at a fraction of the cost of training that is carried out on a much more expensive FFS.

These features will help airlines, TRTO's and FTO's to provide better and more cost-effective training, which surely must be the goal for all those involved in air transport.

References. (Key references only).

1) "Training Value of a Fixed-Base Flight Simulator with a Dynamic Seat" Burki-Coken, J., Sparko, A. L. AIAA, Vol 6564, 2007.

2) "Transfer of Training from a Full-Flight Simulator vs. a High Level Flight Training Device with a Dynamic Seat." Sparko, A. L., Burki-Cohen, J. AIAA, 2010.

3)" The Effect of Simulator Motion Cues on Initial raining of Airline Pilots" Burki-Cohen, J., Go, T. H., AIAA Modeling and Simulation Technologies Conference American Institute of Aeronautics and Astronautics AIAA, 2055-6109, 2005.

4) "The Effect of Simulator Motion Cues on Initial Training of Airline Pilots," American Institute of Aeronautics and Astronautics, AIAA-2005-6109, 2005. From The AIAA Modeling and Simulation Technologies Conference, 2005., Burki-Cohen, J., Tiauw H., Go.

5) "Flight Simulator Fidelity Considerations for Total Airline Pilot Training and Evaluation", Burki-Cohen, J., Tiauw, H. G., AIAA-2001-4425, From, "Proceedings of the AIAA Modeling and Simulation Technologies Conference, Montreal , Canada, 6-9 August 2001.

6) "The effects of enhanced hexapod motion on airline pilot recurrent training and evaluation," Go, T.H., Burki-Cohen, J., Chung, W.W., Schroeder, J.A., Saillant, G., Jacobs, S., Longridge, T., American Institute of Aeronautics and Astronautics, Vol, 5678, 2003.